IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Case No. 05-769)

In the Application of:	)	
	)	
Peter Graham Richardson	)	Examiner: Harry L. Liu
	)	
Serial No. 10/550,227	)	
	)	Group Art Unit: 3662
Filed: Sept. 20, 2005	)	
	)	Conf. No. 7674
Title: Time Delay BeamFormer and Method of Time Delay Beamforming	)	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RULE 1.312 DECLARATION

I, Peter Graham Richardson, of QinetiQ Limited, St. Andrews Road, Malvern, Worcestershire WR14 3PS, England, declare as follows:

1. I am a named inventor of the above-captioned patent application. I am an employee of the Applicant, QinetiQ Limited. If a US patent were to be granted on this patent application, I may receive certain benefits from QinetiQ Limited in consequence. If employed by QinetiQ Limited at the time of grant, each inventor designated in a first patent family receives a monetary award. This award would not exceed $2000. The above-captioned patent application is currently the only pending patent application in this patent family, and no other patents have been granted in this patent family. Should an invention be exploited commercially, an inventor if still employed by QinetiQ Limited is eligible to apply for a commercial exploitation award. This is a monetary award corresponding to a fraction of the net gain to QinetiQ Limited of the commercial exploitation. The net gain to QinetiQ Limited of commercial exploitation of the invention may be affected by the grant of a US patent on this patent application.

2. My CV setting forth my education, publications, and work experience is attached as Exhibit A. I have over 20 years of research experience in adaptive array signal processing techniques for radar and sonar applications. During my career at QinetiQ I have been primarily responsible for the development and assessment of advanced processing techniques for airborne phased array radar.

3. I am currently leader of a team dedicated to advancement of phased array technologies for airborne radar, but my own particular expertise is within the areas of adaptive beamforming algorithms for jammer suppression and space-time adaptive processing (STAP) techniques for clutter and jammer suppression, and I have authored a large number of journal and conference papers on these topics. Recent published material includes "Post-adaptive processing time-delay beamforming for clutter suppression in airborne radar", IET Electronics Letters Vol. 44, No. 5, February 2008, which describes an airborne radar application of the subject of this patent application. My STAP related work has included research into STAP for wideband airborne radar, STAP for bistatic radar applications and STAP techniques for joint mitigation of clutter and terrain scattered jamming. I was awarded a QinetiQ Fellowship in 2002 in recognition of my achievements in the field of STAP.

4. I have reviewed the above-identified patent application, the pending claims, the outstanding Office Action (issued 3rd April 2009) and the following prior art documents: US Patent Application Publication No. US 2002/0122002 in the name of Maalouf et al (hereinafter referred to as "Maalouf"); the abstract to a presentation, and the presentation itself, both entitled "The Effect of Bandwidth on Space-Time Adaptive Processing (STAP)" by Michael A. Zatman presented at the Fifth Annual ASAP '97 Workshop (hereinafter referred to as "Zatman ASAP"); and the paper entitled "Time Delay Steering Architectures for Space-Time Adaptive Processing" by Michael A. Zatman and E. Baranoski in Antennas and Propagation Society International Symposium, 1997 IEEE, pages 2426-2429, XP010246697 ISBN: 0-7803-4178-3 (hereinafter referred to as "Zatman IEEE").

5. Maalouf teaches the use of a conventional space-time adaptive processing (hereinafter referred to as "STAP") architecture to suppress interference

impinging on a GPS receiver while avoiding distortion of a GPS signal. In the architecture of Maalouf, there is a plurality of input channels, each carrying signal from an antenna element. Each channel is sampled at a plurality of points in time to produce a plurality of sampled signals. These signals are provided to a processor, which processes them using conventional STAP techniques to produce a plurality of processed signals. These processed signals are summed together to form a beamformed output. Maalouf considers issues relevant to wideband beam steering (at [0036]), and proposes that these be addressed by using point constraints across the band of interest.

6. I have reviewed the abstract of Zatman ASAP, and I have subsequently reviewed the presentation materials themselves as provided to me by Michael Zatman, the author of Zatman ASAP and the principal author of Zatman IEEE. My understanding following my review of these documents and following discussion with Michael Zatman is that the technical teaching of Zatman ASAP is essentially that of Zatman IEEE.

7. Zatman IEEE relates to the use of STAP for the elimination of clutter in airborne radar systems. As in Maalouf, such systems comprise a plurality of input channels, each carrying signal from an antenna element: each channel is sampled at a plurality of points in time to produce a plurality of sampled signals; and these signals are provided to a processor, which processes them using conventional STAP techniques to produce a plurality of processed signals. Zatman notes that practical performance of STAP algorithms is affected by radar bandwidth. Zatman proposes to reduce the effects of spatial dispersion in a wideband array by using time delay steering of signals received from antenna elements before STAP processing. Zatman proposes that such time delay steering be carried out not only in a spatial dimension, but also in a Doppler dimension.

8. My invention, as described in claim 1 of my patent application, teaches a time delay beamformer comprising a plurality of input channels. Each channel has an associated sampler arranged to sample an input signal carried upon the input

channel at a plurality of points in time to produce a plurality of sampled signals. A processor is arranged to receive the input signals and the sampled signals (or signals indicative of each of the input signals and the sampled signals), and is further arranged to generate space-time processed signals therefrom. A steering time delay is arranged to introduce a steering time delay to these processed signals (or to signals indicative of them) to produce at least two delayed signals. A summer is arranged to generate a beamformed output signal from the delayed signals (or from signals derived from them).

9. Maalouf does not teach the use of a steering time delay of any kind. Maalouf teaches a conventional STAP architecture and beamformer. Maalouf proposes that technical problems associated with wideband beam steering be addressed by point constraints in adaptive processing. Maalouf neither teaches nor suggests the use of a steering time delay, and in particular does not teach or suggest the use of a steering time delay to space-time processed signals.

10. Zatman IEEE does teach the combination of a STAP architecture with steering time delays. Zatman teaches that time delays are applied to a plurality of input channels before any space-time processing takes place. In Zatman, the time-delayed input signals are sampled at a plurality of points, and space-time processing is carried out on the time-delayed input signals and the sampled time-delayed input signals to produce space-time processed signals. These space-time processed signals are then summed to produce a beamformed output signal. An architecture of this general type is illustrated in Figure 1 of my patent application.

11. The teaching of my invention differs from the teaching of Zatman in that I propose time delay steering of space-time processed signals, whereas Zatman proposes space-time processing of time delayed input signals. I have found that this approach is effective to remove beam squint (the variation of beam direction with frequency) without degrading clutter suppression and hence the detection of slow moving targets. Further advantages are discussed in my patent application at page 3, line 23 to page 4, line 6, for example. Figure 5 of my patent

application illustrates the effectiveness in simulation of an exemplary beamformer according to my invention in providing an evident target return; this may be compared to Figure 3 which illustrates the lesser effectiveness in simulation of a comparable beamformer in which space-time processing is carried out on time delayed input signals,

12. It is therefore not apparent to me that the present invention would be reached simply from consideration of the teaching of Maalouf or Zatman.

13. I further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Sec. 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

P. G. Richardson
[PETER GRAHAM RICHARDSON]

Date: 23rd JULY 2009

EXHIBIT A

Curriculum Vitae – Peter Graham Richardson

Mr Richardson graduated from the University of Newcastle Upon Tyne with a first class joint honours degree in Mathematics and Physics in 1976. He has over 20 years of research experience in adaptive array signal processing techniques for radar and sonar applications. During his career at QinetiQ he has been primarily responsible for the development and assessment of advanced processing techniques for airborne phased array radar.

Mr Richardson leads a team at QinetiQ dedicated to advancement of phased array technologies for airborne radar, but his own particular expertise is within the areas of adaptive beamforming algorithms for jammer suppression and space-time adaptive processing (STAP) techniques for clutter and jammer suppression, and he has authored a large number of journal and conference papers on these topics. Mr Richardson's STAP related work has included research into STAP for wideband airborne radar, STAP for bistatic radar applications and STAP techniques for joint mitigation of clutter and terrain scattered jamming. Mr Richardson was awarded his QinetiQ Fellowship in 2002 in recognition of his achievements in the field of STAP.

Representative Publications

1. Post-adaptive processing time-delay beamforming for clutter suppression in airborne radar

Herbert, G.M; Richardson, P.G;
Electronics Letters
Volume 44, Issue 5, Feb. 28 2008 Page(s):378 – 379

2. Benefits of space-time adaptive processing (STAP) in bistatic airborne radar

Herbert, G.M; Richardson, P.G.;
Radar, Sonar and Navigation, IEE Proceedings -
Volume 150, Issue 1, Feb. 2003 Page(s):13 – 17

3. STAP covariance matrix structure and its impact on clutter plus jamming suppression solutions

Richardson, P.G.;
Electronics Letters
Volume 37, Issue 2, 18 Jan 2001 Page(s):118 – 119

4. Space-time adaptive processing for manoeuvring airborne radar

Richardson, P.G.;
Electronics & Communication Engineering Journal

5. Analysis of the adaptive space time processing technique for airborne radar

Richardson, P.G.;
Radar, Sonar and Navigation, IEE Proceedings -
Volume 141, Issue 4, Aug. 1994 Page(s):187 – 195

6. Real-time STAP hardware demonstrator for airborne radar applications

Paine, A.S; Homer, K.J; Medley, J.C; Richardson, P.G;
Radar Conference, 2008. RADAR '08. IEEE
26-30 May 2008 Page(s):1 – 5

7. On the benefits of space-time adaptive processing (STAP) in bistatic airborne radar

Herbert, G.M; Richardson, P.G;
RADAR 2002

8. PACER (Phased Array Concepts Evaluation Rig): design, development and adaptive beamforming experiments

Richardson, P.G.; Adams, F.J.; Lewis, K.J.; Medley, J.C.;
Phased Array Systems and Technology, 2000. Proceedings. 2000 IEEE International Conference on
21-25 May 2000 Page(s):421 – 424

9. Adaptive space time processing for forward looking radar

Richardson, P.G.; Hayward, S.D.;
Radar Conference, 1995., Record of the IEEE 1995 International
8-11 May 1995 Page(s):629 – 634

10. Array signal processing using digital subarrays

Nickel, U.; Richardson, P. G.; Medley, J. C.; Briemle, E.;
Radar Systems, 2007 IET International Conference on
15-18 Oct. 2007 Page(s):1 – 5

11. Cross modulation cancellation for airborne phased array radar

Mellor, I. M.; Adams, F. J.; Richardson, P. G.;
Radar Systems, 2007 IET International Conference on
15-18 Oct. 2007 Page(s):1 – 4

12. On the benefits of space-time adaptive processing in FM ranging airborne radar

Herbert, G.M.; Richardson, P.G.;
Waveform Diversity & Digital Radar Conference - Day 2: From Active Modules to Digital Radar, 2008 IET
9-9 Dec. 2008 Page(s):1 - 6

13. The relative merits of pre/post-Doppler STAP

Savy, L.; Richardson, P. G.; Medley, J.C.; Buerger, W.;
Waveform Diversity & Digital Radar Conference - Day 2: From Active Modules to Digital Radar, 2008 IET
9-9 Dec. 2008 Page(s):1 - 5

14. Space-time adaptive processing for manoeuvring airborne radar

Richardson, P.G.;
Space-Time Adaptive Processing (Ref. No. 1998/241), IEE Colloquium on
6 April 1998 Page(s):5/1 - 5/7

15. Effects of manoeuvre on space time adaptive processing performance

Richardson, P.G.;
Radar 97 (Conf. Publ. No. 449)
14-16 Oct. 1997 Page(s):285 - 289